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COVER SHEET FOR TECHNICAL MEMORANDUM

ITLE- Analysis of Operations and Constraints Associated With the Mobile Service Structure (MSS) At Launch Complex 39

TM-68-2032-1

DATE- May 8, 1968

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AUTHOR(S)- G. J. McPherson Jr.

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ABSTRACT

This memorandum examines the support required of the Mobile ervice Structure at LC-39. An analysis of Apollo/Saturn V SV proces-ing, as well as related contingency operations, has allowed identifi-ation of the significant constraints levied upon LC-39 by the MSS.

The findings of the study indicate that:

a. The most significant constraint is associated with delaying access to the SC following a scrub decision.

b. Modifications to MSS-related hardware and modus operandi would allow significant reduction in SC fluid servicing timelines.

c. The requirement to accomplish propellant "hot flows" as part of MSS revalidation exercises jeopardizes the capability of KSC to meet the launch rates specified in APD-4H. It will also negate the possibility of an increased launch rate.

It is recommended that:

a. The MSS be returned to its launch-pad position prior to commencing LV ordnance operations during scrub turnarounds.

b. KSC assess the benefits and tradeoffs involved with an even earlier MSS return.

c. KSC continue assessment of the modifications which would reduce SC fluid servicing timelines, specifically those directly beneficial to launch countdown and scrub-turnaround operations.

d. KSC continue assessment of MSS revalidation requirements for possible deletion of the propellant "hot flows."

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BELLCOMM, INC.
1100 Seventeenth Street, N.W. Washington, D. C. 20036

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DATE: May 8, 1968

FROM: G. J. McPherson Jr.

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TECHNICAL MEMORANDUM

1.0 INTRODUCTION

The Mobile Service Structure (MSS), which is required to provide access and servicing functions to the Apollo/Saturn V space vehicle during its pad processing, levies certain operational constraints upon Launch Complex 39. These constraints, which are associated with normal space vehicle processing as well as contingency operations, are the topics of discussion in this memorandum. The basic information presented herein is based on AS-501/CSM 017 (Apollo 4) data and AS-502/CSM 020 (Apollo 6) planning. Known differences for AS-502/CSM 020 and subsequent space vehicles are included in the applicable discussions of this memorandum.

Only launch pad A was considered for the analysis of MSS transfer times. Launch pad B will be the subject of a follow-on study which will be issued as an addendum to this memorandum.

The figures and discussions included in this memorandum provide information concerned with the following areas of interest:

1. physical and functional makeup of the MSS
2. detailed timelines of MSS related functions during normal and contingency operations
3. operational considerations and constraints associated with the MSS
4. projected usage of the MSS for lunar mission support
5. conclusions and recommendations.

2.0 REQUIREMENTS FOR AN MSS

The Apollo/Saturn V space vehicle is "stacked" on a mobile launcher platform (LUT) in the Vertical Assembly

Building (VAB) and proceeds through intensive testing prior to being transferred, intact, to the launch pad. This "stacked" concept, although greatly reducing the SV's pad stay time, could not eliminate the requirement for a servicing capability at the launch pad. Many servicing functions such as select ordnance installations, ordnance connections, hypergolic propellant loading, etc., cannot be accomplished prior to the SV's movement to the launch pad because of safety constraints. Other servicing functions such as CSM cryogenic servicing, LM SHe servicing, fuel cell activation, etc., must be accomplished during the final launch preparations due to limited system lifetimes.

Another requirement which directly and indirectly affects the degree of servicing capability necessary at the launch pad is the Flight Readiness Test (FRT). The FRT, which is the final SV systems integrated test, requires that the SV be mated to all launch pad interfaces and also be exposed to the pad environment which is expected on launch day. Because of the circuitry which is stimulated as part of the FRT plus_time simulation, it has been established that hypergolic servicing will occur subsequent to FRT completion.

The additional requirement to enclose the Apollo SC within a controlled environment while still allowing total access to all stages of the SC, created the "silo" work platform configuration presently used on the LC-39 MSS.

The most demanding of all the servicing structure requirements evolves from the necessity to have complete access to <u>all</u> locations of the SV, internal and external, for troubleshooting, repairs, modifications, and possible repetition of any VAB preparations and/or testing should the need arise. The probability of encountering a situation which would require returning the SV to the VAB, is greatly reduced by providing a flexible servicing/access capability at the launch pad.

Now that the significant factors which require an extensive launch pad servicing capability have been identified, the reasons for not providing these functions via the LUT should be discussed. The LUT is required to provide certain limited access and servicing functions to the SV during final launch preparations until liftoff. These are generally time-critical services such as LV battery installations, LV cryogenic loadings, SV pressurization systems servicing, astronaut ingress/egress, etc. To also provide the capability for <u>all</u> of the other servicing/access requirements previously described would far exceed the allowable size and weight limits of the LUT. To add any specific capabilities to the LUT requires an evaluation of advantages gained vs. penalties accepted for each one considered.

The most beneficial area to consider transferring capabilities from the MSS to the LUT is associated with the servicing of the CSM and/or LM cryogenic systems. The optimum situation would be to have both the capability to service all SC cryogenic systems from external disconnects (manual or fly-away) and to eliminate the need for a separate servicing structure during scrub-turnaround operations. Neither of these situations can be realized at this time for several reasons, the most significant of which are:

a. SC weights would increase intolerably in providing a totally external cryogenic servicing capability from the LUT.

b. The LM/SLA interface inflight disconnect would become increasingly complex and, hence, less reliable.

c. Many problems, unknowns, and prohibitive cost are involved with providing SHe capabilities from the LUT. (See Reference 16 for detail from MSC study.)

d. A servicing structure is presently required for numerous functions during scrub turnarounds such as S-IVB post-load leak checks, S-IVB APS gas removal, switching fuel cells to external reactants during SM cryogenic servicing, etc.

It can be seen, therefore, that a servicing structure must contain considerable equipment and must be situated rather close to the SV to provide all of its servicing and access functions. The necessity to afford the servicing structure and its associated equipment maximum protection from the SV generated launch environment, created the "mobile" servicing structure concept (MSS) presently employed at LC-39. Figure 1 provides visibility into the physical and functional relationships between the MSS, SV, and LUT at the launch pad. Appendix I contains a physical and functional description of the MSS and its associated support equipment.

3.0 MSS SUPPORT PRIOR TO THE LAUNCH COUNTDOWN

Normal pad processing of an Apollo/Saturn V space vehicle varies from vehicle to vehicle but generally will approach six to eight weeks in duration. The MSS is moved into place shortly after completion of the S/A #9 validation tests and remains at the launch pad for the entire six to eight-week period except during the countdowns for the Countdown Demonstration Test (CDDT) and the launch itself. The initial move of the MSS to the launch pad from start of C/T preparations through final securing at the launch pad covers approximately a 24-hour time-span*. This is not seen as a constraint on the complex operation assuming both C/T's are available and the MSS transfer preparations are accomplished in parallel with the LUT/SV transfer operation.

During the period of time prior to initiating the launch countdown, the MSS supports SV processing extensively by providing access and servicing capabilities. It is during this period of time that SV checkout, SV hypergolic servicing, and the CDDT are accomplished. The MSS is not seen as levying any significant constraints on the launch complex operation during this time-frame other than those associated with the CDDT countdown.

MSS support of a CDDT countdown is considered herein to be identical or less constraining than that required during a launch countdown; both will be discussed as one in the subsequent section. Contingency pad operations such as scrubs and hurricane returns will also be discussed in subsequent sections.

4.0 MSS SUPPORT DURING THE LAUNCH COUNTDOWN

For purposes of this discussion, the launch countdown will be considered to also include the countdown preparations which commenced at T-104 hours for AS-501. During the five-day span of the launch countdown, the MSS was involved in numerous operations. The general sequence of the most significant operations is as follows:

a. SC system checks

b. installation and connection of SC ordnance initiator devices

c. SV mechanical buildup

d. LV system checks and calibrations

e. SC heavy ordnance connection and verification

f. SC helium servicing

g. SC hypergolic line disconnect

h. S-IVB APS gas removal

i. fuel cell activation

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*See Reference 7 for detail concerning the initial transfer of the MSS to the launch pad.

j. SC cryogenic servicing

k. SC cryogenic GSE disconnect and removal

l. IU and SLA antenna hat removals

m. MSS platform breakup

n. MSS transfer to park-site.

Although all of the items above involve the MSS and are a significant part of the SV critical timeline, those accomplished independent of MSS platform breakup (items a through j) do not cause the MSS to constrain the launch complex operation. This is based on the premise that an equal amount of time would be required to perform the operations regardless of the servicing medium (MSS or LUT).

This then leaves only those items which are influenced by preparations for platform breakup, platform breakup itself, and the movement of the MSS away from the launch pad as possible constraints. Preparations for platform breakup commence at approximately T-21 hours. The remainder of this section shall be concerned with MSS-related functions subsequent to that "T" time.

The operations associated with platform breakup were initially sequenced, based on two considerations. First, "In what sequence must the platforms be opened to best support LV and SC requirements?" and, second, "How late can platform breakup commence and still have the MSS ready to be jacked by T-11 hours?"

The answer to these questions for AS-501 is reflected in Figure 2. For AS-502 and subsequent, the individual timelines will remain basically unchanged, but the sequence of platform breakup will be revised as required to satisfy the LV and SC needs. Appendix II contains a description of the significant activities associated with the breakup of each platform during the AS-501 launch countdown and the anticipated changes for subsequent SV's.

Concurrent with MSS platform breakup, numerous other functions are being accomplished in preparation for the MSS move (see Figure 2). By T-11 hours, the auxiliary damper is disconnected and the MSS is ready to be jacked. As soon as the MSS is jacked to transfer height, the MSS move toward the park site commences. As the MSS is moved away from the launch pad, the primary damper is connected to the SV and preparations are made for connection of the S&A devices.

The MSS servicing platforms are closed while the MSS is enroute to the park-site. Upon arrival at the park-site, the MSS is lowered, secured with the holddown clamps, and the MSS/park-site interfaces mated. The C/T is then secured, the MSS Operational TV (OTV) prepared for launch, and the park-site cleared of all personnel at T-4 hours.

Based on the previous conclusion that the MSS does not constrain the launch countdown prior to platform breakup and the fact* that the MSS no longer constrains the operation once it has moved beyond the 35-foot point, the only time-frame left to examine for constraints is during platform breakup and movement of the MSS to the 35-foot point. To accomplish this, a knowledge of how the Apollo/Saturn V SV countdowns originated is required.

The launch countdown for both AS-501 and AS-502 were developed in very much the same way: that is, the LV and SC countdowns were outlined independent of MSS support. Once the LV and SC countdowns were integrated, the composite input was presented to the support group for them to develop their support countdown including platform functions. As a result of developing the support countdown, several changes to the LV and SC sequences were necessitated. This was primarily due to the limited platform breakup which could be accomplished simultaneously. The changes to the LV and SC sequences, however, did not add serial time to the countdown, but did provide a staggered platform breakup which could be accomplished within the existing safety constraints and manpower allocations.

It can then be concluded that platform breakup functions do not add any significant serial time to the launch countdown but constrain the operation in such a way as to dictate <u>when</u> and <u>in what sequence</u> certain SV functions must be accomplished. This then leaves only those remaining MSS breakup functions, during which SV work cannot be accomplished in parallel, as the only MSS constraints which actually add serial time to the launch countdown. From Figure 2, it can be seen that this period of time occurs between T-11 hours and T-10 1/4 hours when the SV and LUT S/A's must be cleared during movement of the MSS away from the SV. Thus, only 45 minutes of serial countdown time can be <u>directly</u> attributed to the MSS.

5.0 MSS SUPPORT DURING SCRUB-TURNAROUND OPERATIONS

Immediately following a decision to scrub, many actions are initiated to expedite return of the MSS to the launch pad and

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*Discussed in Section 7.2.2.

to ready the SV for another launch attempt. Figure 3 reflects the timelines for return of the MSS to the launch pad as well as the significant SV activities that were planned for AS-501.

Concurrent with draining LV cryogenics, the MSS is prepared at the park-site for return to the launch pad. The MSS timelines have been arranged such that the MSS arrives at the 35-foot point at scrub plus 11 hours, some 30 minutes prior to completion of the LV S&A exchange. While standing at the 35-foot point, the MSS servicing platforms are opened and the MSS is jacked to its approach height.

S&A exchange completes at scrub plus 11 1/2 hours at which time the primary damper arm is retracted and the MSS is permitted to complete the move to its pad position. The MSS is then lowered, secured, and the auxiliary damper arm connected. During actual movement of the MSS within 35 feet of the SV, the SV itself and the LUT S/A's are cleared of all personnel. The MSS/pad interfaces are then mated and the servicing platforms closed. The MSS is ready to <u>fully</u> support scrub-turnaround operations at scrub plus 19 hours. Scrub-turnaround timelines for AS-502 are unique due to a number of special considerations/waivers and will not be discussed herein.*

Based on the same rationale involved in determining the amount of serial time involved with removing the MSS during the launch countdown, it can be seen that the SV and LUT S/A's must be cleared for approximately 45 minutes during return of the MSS. This again is the only serial time which can be <u>directly</u> attributed to the MSS on an AS-501 type scrub turnaround.

The MSS will also cause considerable delay in <u>acquiring</u> access to the SC locations until the respective servicing platforms are closed. Although this was not a major consideration on the AS-501 type mission, it will become increasingly significant as a lunar mission becomes imminent. This factor will be treated in the discussions of Section 8.2.

6.0 MSS SUPPORT DURING HURRICANE TRANSFER OPERATIONS

The operations associated with MSS removal during a hurricane alert look very much like those for the normal countdown removal operation shown in Figure 2. The significant exception to this is in breakup of the servicing platforms. Since, during a hurricane alert, it is very unlikely that the platforms will be involved in any complicated operations,** they can all be

*See Reference 12 for AS-502 scrub-turnaround timelines.

**Figure 5-2 of Reference 7 reflects SV return times vs SV configuration for all times subsequent to hypergolic loading.

turned over to the support group simultaneously by decision plus 4 hours and breakup completed some three hours earlier than in the normal countdown.

The preparation of the MSS for its move to the park-site is accomplished in parallel with preparations to move the LUT/SV to the VAB. It can be seen in Reference 7 that the transfer of the LUT/SV requires 20 hours after the decision has been reached. The transfer of the MSS to the park site requires 18 hours.

Assuming that both C/T vehicles are available, the MSS is ready to start its horizontal motion by decision plus 10 1/2 hours. The LUT/SV is not ready to start its horizontal move until decision plus 13 hours, at which time the MSS is almost half way to the park-site. It can further be seen that the LUT/SV transfer would still require 20 hours even if the MSS were not at the launch pad at the time of decision.

From this standpoint, it can be concluded that the MSS does not constrain the operation during a hurricane transfer.

7.0 <u>OTHER OPERATIONAL CONSIDERATIONS</u>

7.1 <u>Wind Constraints</u>

The wind constraints associated with the MSS are as follows:

a. MSS standing at the launch pad or park-site <u>without</u> holddown clamps--63 mph peak at 30 feet above grade.

b. MSS standing at the launch pad or park-site <u>with</u> holddown clamps closed--85 mph peak at 30 feet above grade.

c. MSS standing at the launch pad (no SV) or park-site <u>with</u> holddown clamps closed and grouted--125 mph peak at 30 feet above grade.

d. MSS standing at the launch pad (SV present) <u>with</u> holddown clamps closed and grouted--105 mph peak at 30 feet above grade*.

e. MSS being transferred on the C/T--46 mph peak at 30 feet above grade or 28.5 mph steady state at 30 feet above grade, whichever is less.

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*Allowable wind is lower when LUT/SV are present due to total loading seen by the launch pad.

f. MSS at launch pad with platforms closed around the SV--platform annulus rings must be folded back when winds exceed 32 knots peak at 30 feet above grade.

g. The MSS is declared non-operational (platforms and elevator operation prohibited)--28 mph peak at 30 feet above grade at the launch pad and 63 mph peak at 30 feet above grade at the park-site.

The above constraints are engineering design values which in some cases will be further constrained for operational reasons. An example of this is in the wind constraints associated with transfer of the MSS on the C/T.

The transfer of the MSS is operationally limited (see Reference 7) to values of wind which would cause the pressure on a corner cylinder of the C/T to exceed its maximum allowable values. The wind magnitude which corresponds to this maximum value is 35 knots peak (41 mph) at the 30-foot level above grade. This is equivalent to 50 knots at the 195-foot level.

It should also be noted that the presence of the MSS at the launch pad does not directly influence the SV where winds are concerned. The SV is limited to 63.2 knots peak at the 60-foot level above grade regardless of which damper-arm system, primary or auxiliary, is attached.

7.2 Transfer Operations

7.2.1 Transfer Speeds

The speeds at which the MSS can be transported by the C/T are identical to those for transfer of the LUT/SV combination and are self-imposed limits within the C/T systems. The maximum transfer speeds for a loaded C/T are as follows:

a.	straightaway	0.80 mph
b.	up-ramp	0.50 mph
c.	down-ramp	0.25 mph

From actual transfer operations of the MSS during AS-501 processing, it was determined that more realistic average speeds should be utilized for calculating MSS transfer timelines. It was also determined that reduced speeds were required at certain locations along the crawlerway. The recommended average speeds which should be used for determining transfer timelines are as follows:

a.	straightaway	0.75 mph
b.	up-ramp	0.40 mph
c.	down-ramp	0.25 mph
d.	curves	0.50 mph
e.	across blacktop strips	0.30 mph
f.	within 35 feet of the SV	0.10 mph

Figure 4 reflects the transfer timelines which are a result of experience gained during AS-501 processing. As the notes on the figure indicate, the timelines are actual horizontal movement times and do not include any delays for clearence, coordination, winds, etc.

The transfer of the MSS from the park-site to the launch pad takes 2 hours and 49 minutes, some 29 minutes less than the transfer from the launch pad to the park-site. This is solely due to the difference in allowed speeds for up and down-ramp travel.

It should also be noted that winds influence the MSS transfer timelines. For lower magnitudes of wind, the criterion involves monitoring the C/T corner cylinder pressures and adjusting the C/T speed as necessary to maintain its parameters within redline limits. As previously mentioned, the C/T corner cylinder pressure redline corresponds to 35 knots at 30 feet above grade; transfers during winds which exceed this value would not be considered unless the situation warranted such a real-time decision.

7.2.2 MSS Distance Requirements During Hazardous Launch Pad Configurations

Criteria exist which require the MSS to be certain minimum radial distances from the launch pad whenever the SV configuration represents a potential hazard to personnel and/or equipment. These configurations can be categorized as follows: LV S&A devices being connected or disconnected, SV in terminal count for launch attempt, and LV cryogenics loaded.

The criterion concerning the connection/disconnection of the S&A devices requires the MSS to be a minimum of 35 feet from the SV if personnel are on-board the MSS. The criterion for the MSS during the terminal count for a launch attempt requires the MSS to be a minimum of 2470 radial feet from the launch pad. This is to protect the MSS structure and associated equipments from major blast damage should the launch attempt result in a catastrophic condition. It should be noted that the propellant loading distance constraint automatically eliminates the possibility of personnel being as close as 2470 radial feet during the terminal count.

The criterion involved with location of the MSS when cryogenics are on board is more complex, and a chart is necessary to reflect the constraints. This results from the personnel hazard being directly related to the volume of propellants loaded and their equivalent blast potential. Figure No. 5 reflects the minimum distances required for each LV cryogenic configuration and the latest times that the MSS transfer could commence for each individual distance and still satisfy the constraint during MSS removal from the launch pad; also, the earliest times that MSS transfer back to the pad could commence and still satisfy the constraints as the LV cryogenics are being unloaded. The MSS transfer times were taken from Figure 4.

During LV cryogenic loading, it can be seen (see Figure 5) that to satisfy the 850-foot (radial) constraint for start of LO_2 line chilldown, you must commence horizontal movement of the MSS towards the park-site no later than T-6 hours 10 minutes. This will allow the MSS to be at the 850-foot point by T-5 hours 25 minutes. It can further be seen from Figure 5 that, once the MSS has satisfied the 850-foot constraint, it will inherently satisfy all the remaining distance constraints as long as it continues to move at nominal speeds.

During LV cryogenic unloading subsequent to a scrub at T-0, the most stringent constraint (see Figure 5) is to not arrive at the 2650-foot point (radial) prior to the S-IC LO_2 tank being 67% drained. This configuration is nominally reached at scrub plus 3 hours 50 minutes. Based on the MSS requiring 1 hour 37 minutes to travel from the park-site to the 2650-foot point (see Figure 4), the MSS could not start its horizontal move any sooner than scrub plus 2 hours 13 minutes. Nominally, it requires 3 hours 45 minutes to prepare the MSS for a move from the park-site under scrub-turnaround conditions.

Both of the preceding paragraphs have been concerned only with LV cryogenics as the limiting configuration. In both cases, loading during the launch countdown and unloading during a scrub operation, neither constraint presently draws much concern because current modus operandi has made the S&A operations a more stringent distance constraint for the MSS than the cryogenic operations.

The S&A constraint is such that if the MSS has personnel on board, it must be a minimum of 35 feet from the SV during S&A operations. From Figures 2 and 4, it can be seen that to be at the 35-foot point by T-9 hours 15 minutes of the launch countdown, the MSS must start its horizontal move by T-9 hours 20 minutes. This is some two hours sooner than the time dictated by the propellant loading constraint. Similarly, from Figures 3 and 4, it can be seen that to prevent the MSS from arriving at the 35-foot point sooner than scrub plus 11 hours 30 minutes, the MSS cannot leave the park-site any sooner than scrub plus 8 hours 45 minutes. This is some 6 hours 32 minutes later than the time dictated by the propellant unloading constraint.

For obvious operational benefits, the MSS move is scheduled earlier than required in both cases as reflected in Figures 2 and 3. It should be noted in the scrub operation that the MSS would be required to stop and wait some 90 minutes before proceeding beyond the 35-foot point. Part of this time is used to open the servicing platforms and to jack the MSS to its approach height. Both of these operations can be done enroute if desired.

The S&A operations could be accomplished with the MSS in place at its pad position providing all personnel are cleared from the MSS. This approach would add serial time to the launch countdown operation but could eliminate some serial time from the scrub-turnaround operation. The feasibility of returning the MSS to its pad position prior to performing S&A operations will be discussed further in Section 8.0 herein.

7.2.3 Return of the MSS to the Launch Pad for Scrubs At Various "T" Times

Should a scrub become necessary after initiating MSS breakup, the return time* will be a function of where the MSS is at the time of decision, and how soon its return could commence without violating any distance constraints (reference Section 7.2.2).

Figure 6 which consists of several inter-related plots reflects MSS return times for each of the conditions which constrain its return. An explanation of the plots is contained in Appendix III.

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*Return time is the total time from scrub decision until the desired servicing platform is closed.

7.3 Miscellaneous Constraints

7.3.1 Theodolite Sightings

As previously mentioned, MSS Platform No. 2's interference with the line-of-sight has been resolved for AS-502 and subsequent SV's. This is not so for the west elevator itself. The theodolite line-of-sight passes through the west elevator shaft and is broken whenever the elevator passes by that elevation.

Although this is a nuisance item, it will continue to be handled procedurally. During theodolite sightings, the west elevator is secured (power interrupted) at an elevation above the theodolite line-of-sight.

Securing one of the two MSS elevators has not proven to be a hindrance to the overall operation as the majority of the work being performed during that time-frame does not require movements of large numbers of equipment or personnel via the elevators.

7.3.2 MSS Platform Operations

The KSC Safety Office has recently clarified its criteria concerning the clearance of personnel from certain areas during opening or closing the MSS servicing platforms. The following areas must be cleared during actual platform motion:

a. unprotected areas on the LUT/SA's and MSS platforms below the platform being operated

b. open portion of the LUT zero level.

This is not visualized as a significant constraint as clearance times will be minimized by "real-time" coordination between those affected and the respective safety representatives.

8.0 PROJECTED MSS OPERATIONS

8.1 Proposals Currently Being Assessed For Servicing Systems

Many changes to hardware and modus operandi are currently being assessed and/or implemented for the servicing systems at LC-39; some of them are MSS-related and should be mentioned.

SM Cryogenic Servicing

On AS-501, SM cryogenic servicing (LO_2 and LH_2) operations were accomplished serially due to the potential personnel hazards associated with cryogenic liquids and the flammability of GH_2. Based on the experience gained during AS-501, KSC found that it was possible to accomplish a part of these operations in parallel.

On AS-502, the pressurization operations for LO_2 and LH_2 servicing were accomplished in parallel. This reduced the SM cryogenic servicing time some 2-2 1/2 hours. It is expected that this mode of operation will be retained for all subsequent vehicles and implemented for launch countdowns and scrub turnarounds when applicable.

SM/LM Cryogenic Servicing

KSC is currently assessing the feasibility of servicing SM LO_2 parallel with LM SHe. It is not known at this time which operations can be paralleled, but total simultaneous servicing could potentially reduce the launch countdown servicing time by about six hours. This same benefit would also be available during scrub-turnaround operations.

It is anticipated for the earlier manned Apollo/Saturn V space vehicles that these operations will be performed serially and consideration be given to simultaneous servicing as experience is gained. Consistent with safe practices, the objective is to have these functions as parallel operations for the lunar mission countdowns.

CSM/LM GHe Servicing

At present, the helium transfer unit (S14-009), which is common to CSM and LM GHe servicing, cannot support simultaneous servicing between the two SC. The unit currently has the capability to control (flow, temperature, etc.) only a single output. These single outputs do, however, allow simultaneous servicing within the respective spacecrafts themselves.

Modifications to the transfer unit and interlocking circuitry could make a parallel servicing operation feasible between the CSM and LM. KSC is currently evaluating this possibility and will make its recommendations known in the near future. Totally paralleling the CSM and LM GHe servicing could potentially reduce the launch countdown servicing time by 4-5 hours.

LM Hypergolic Servicing

LM/RCS fuel servicing cannot be accomplished in parallel with either of the LM main-stage fuel systems because of undesirable back-pressures experienced at the RCS units. This is a result of all three fuel systems utilizing a common vent to the disposal unit. Plumbing the RCS vent line to the existing MSS vent stack similar to the RCS oxidizer system would eliminate the back-pressure problem.

KSC is currently assessing such a modification and also the parallel servicing operation to determine their feasibility. Based on preliminary hypergolic servicing schedules for a "full-up" Saturn V, this would allow a 12-24 hour reduction in hypergolic servicing times.

8.2 Support of Manned and Lunar Apollo/Saturn V SV's

MSS support of Apollo/Saturn V SV's during manned and lunar missions warrants two separate considerations. The first is concerned with normal pad processing and scrub-turnaround operations. The second consideration is concerned with the capability of the MSS to support Apollo/Saturn V SV's at the launch rate specified in APD-4H.

Launch Countdown

The preliminary launch countdown for a manned or lunar Apollo/Saturn V SV (Reference 14) reflects many new checkout and servicing operations not required by unmanned SV's. Although the majority of these additional operations will necessarily be performed via MSS servicing Platforms 3 and 4, the individual MSS timelines associated with MSS breakup are expected to remain unchanged. There will, however, be substantial revision to the overall length of the launch countdown, a resequencing of some MSS breakup functions, and a general movement of all functions to an earlier "T" time; none of these changes is directly attributable to the MSS.

Based on the preliminary KSC planning, it can be concluded that:

1. The existing MSS operations will not be any greater constraint during a manned or lunar launch countdown than they were during unmanned launch countdowns.

2. The MSS will not levy any significant new constraints upon LC-39 during support of manned or lunar launch countdowns.

Scrub Turnaround

Preliminary KSC planning (Reference 10) indicates that a scrub turnaround of manned and lunar-mission SV's will be comparable in length to those planned for unmanned SV's. It also indicates that the number of operations performed via the MSS servicing platforms has greatly increased, primarily due to the presence of a Lunar Module and its associated checkout/servicing requirements. These seemingly contradictory statements are understandable in light of the assumptions made by KSC for lunar-mission scrub-turnaround planning. The assumptions are concerned with probable deletion and/or possible waiver of several significant functions presently required on Apollo/Saturn V SV's. The assumptions also call for paralleling certain hazardous operations which currently are performed serially.

As in the launch countdown, the additional checkout and servicing requirements during scrub turnaround will cause some of the MSS functions to be performed at different "T" times, but the basic MSS transfer and platform operation timelines will remain unchanged. Based on the planning reflected in Reference 10, it appears that the MSS constraints upon LC-39 during manned and lunar-mission scrub turnarounds will be essentially identical to those for unmanned SV turnarounds, with one exception. This concerns the item mentioned, but not discussed, in Section 5.0 and relates to the delay imposed upon SC turnaround operations because the MSS servicing platforms are not available until two or three hours after completion of LV ordnance operations. The remainder of this section will be devoted to outlining the changes necessary to allow availability of the SC servicing platforms immediately upon completion of the LV ordnance operations. This will reduce the scrub turnaround "long pole" by at least two hours.

The present modus operandi for scrub-turnarounds requires the MSS to remain a minimum of 35 feet from the LV until completion of the LV ordnance operations. As explained in Section 7.2.2, this constraint is personnel oriented. An alternate method for satisfying the constraint is to move the MSS onto its pad position but clear all personnel during the LV ordnance operations. This approach offers some significant benefits but must be accomplished without impacting the scheduled LV operations or the benefits will be reduced. The immediate benefit would manifest itself in the form of access to the SC at least two hours earlier than is presently possible.

Figure 7 has been prepared by imposing the earlier MSS return upon the preliminary KSC turnaround planning (Reference 10). As can be seen in Figure 7, the movement of the MSS back to the launch pad could be scheduled to take full advantage of the time during which the LV is being prepared for the ordnance operations. Some facts and a few assumptions were prevalent in devising this approach and are stated here as a basis for the plan's feasibility.

a. MSS horizontal movement must be scheduled to allow departure from the park-site by scrub plus 3 hours 45 minutes. This will allow arrival at and departure from the safety inspection constraint distance* no later than scrub plus 6 1/2 hours.

b. MSS preparations for horizontal movement require 3 1/4 hours of work. It is assumed that the park-site personnel can acquire access by scrub plus 30 minutes which will allow MSS departure by scrub plus 3 hours 45 minutes.

c. The Engine Servicing Platform (ESP) transporter, which is now secured some 600 feet down the launch pad ramp, must be completely under the LUT by scrub plus 7 hours 5 minutes to avoid delaying MSS movement. It has been assumed that the necessary support personnel can acquire access to the required area in parallel with the safety inspection. Movement of the ESP transporter must commence by no later than scrub plus 6 hours 20 minutes.

Once the MSS arrives at its pad position, adequate time remains to make it secure and close Platforms 3 and 4. The MSS would then be cleared of all personnel during LV ordnance operations. Upon completion of the pad-clear time, the return of MSS personnel would be required to close the remaining platforms and to connect the necessary facility interfaces.

It is also feasible that an even earlier return of the MSS could be realized. This would require additional evaluation of tradeoffs but generally would necessitate the following ground rules:

a. Departure of the MSS from the park-site could be accomplished earlier if <u>total securing</u> were not accomplished at the park-site during the countdown operation.

b. Departures of the MSS from the park-site sooner than scrub plus 2 hours 13 minutes and scrub plus 3 hours 19 minutes would require <u>relaxation</u>

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*Assumed to be 1350 radial feet for this study. Actual criterion requires that the MSS remain outside the perimeter fence which is approximately 1200 radial feet from the SV.

of the propellant unload and safety inspection distance constraints, respectively.

c. Departures of the MSS from the 1350-foot point prior to scrub plus 6 hours 10 minutes would require a more expedited movement of the ESP transporter up the ramp.

Return of the MSS another 45 to 60 minutes earlier would allow adequate time for all MSS platforms to be closed prior to LV ordnance operations. This would not reduce the total turnaround time but it would eliminate returning large numbers of support personnel to the MSS platform levels subsequent to the LV ordnance operations.

Support of APD-4H Launch Rate

At present, APD-4H reflects future Apollo/Saturn V SV launches at 10-week intervals. It also reflects that two launch pads will be used to support the launch effort. In order to realistically evaluate whether or not the MSS could be a constraint in attaining the future launch rates, certain assumptions must be made.

The 10-week interval between SV launches is not compatible with the interval between lunar-launch opportunities. Optimistically, the SV launch interval could be reduced to eight weeks by the time the first lunar mission is attempted. For purposes of this discussion, an eight-week launch interval will be assumed.

The pad stay time for Apollo/Saturn V SV's is currently anticipated to be six weeks* in duration for AS-505 and ultimately reduced to approximately four weeks soon thereafter. The longer pad-stay time could cause the MSS to become a constraint or potential constraint dependent upon the evolution of the MSS revalidation requirements. The six-week pad-stay time will be considered as "worst case" for this discussion.

MSS revalidation requirements include "hot" flows of both the cryogenic and hypergolic servicing systems. The capability to accomplish the hot flows other than at the launch pad does not presently exist. The revalidations also include electromechanical functional checks, leak checks and calibrations which could be accomplished at the park-site. The latter are, however, prerequisites for the "hot" flows. Revalidation of the MSS currently requires four weeks.

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*The MSS would be required at the launch pad within two days after SV arrival to assure the six-week pad-stay time.

The remaining consideration is concerned with the two vs. one launch-pad approach. The two-pad approach would find launches occurring on alternate launch pads. MSS revalidation would necessarily start on the launch pad intended for the subsequent launch while the prior pad is being refurbished. This in turn would require MSS revalidation to be complete in sufficient time to move the MSS back to the park-site while the SV is moved to the launch pad. This would require that MSS revalidation be at least three days shorter than for the one-pad approach. The one-pad approach would find launches occurring on the same launch pad and MSS revalidation being accomplished on the other.

It is obvious that when considering both the six-week SV pad-stay time and the four-week MSS revalidation time, eight-week launch intervals are not possible regardless of the one or two-pad approach. Assuming a four-week SV pad-stay time is possible, then an eight-week launch interval would be feasible but would not allow time for any schedule slippages. The schedule would be even tighter were the two-pad approach utilized.

It appears that the most attractive solution would be elimination of the MSS "hot flows," hence, no requirement to move the MSS from the park-site until the subsequent SV has been transferred to the launch pad. This would also lend itself to a real-time decision as to which launch pad to use, if refurbishment of the previously used pad did not already negate an eight-week launch interval.

KSC is currently assessing methods of deleting the MSS "hot flows" without sacrifice of servicing system confidence. The approach currently being evaluated would rely on a gross decontamination, i.e., flush and purge, of the hypergolic systems, to limit system exposure times as well as to prepare the systems for refurbishment, repair, modification, and checkout. The systems would then undergo periodic electromechanical checkouts and leak checks to verify their readiness to support SV processing.

Although a decision is not expected in the immediate future, it appears very likely that the MSS revalidation "hot flows" can be eliminated. It also appears to be a safe assumption that the remaining revalidation requirements could be satisfied at the park-site within a time span consistent with meeting either four or six-week SV pad-stay times.

9.0 <u>CONCLUSIONS</u>

The MSS levies many operational constraints upon LC-39 but <u>does not in itself</u> claim excessive amounts of serial time during support of SV checkout, launch countdown, scrub-turnaround, and other contingency operations. This is mainly because most of the MSS operations are presently accomplished in parallel with other required operations. The one significant exception is the delay in acquiring access to the SC locations following a scrub decision.

There are no significant MSS caused constraints associated with fluids (hypergolic, cryogenic, and GHe) servicing operations. There are, however, several modifications to MSS-related hardware and modus operandi being assessed which could significantly decrease total servicing timelines.

The elimination of the MSS revalidation "hot flows" would allow the MSS to support even the most optimistic lunar Apollo/Saturn V SV launch schedules regardless of the one or two launch-pad approach.

10.0 RECOMMENDATIONS

a. Return the MSS to the launch pad as soon as possible following a scrub decision; initially, soon enough to allow closing Platforms 3 and 4 prior to clearing the area for LV ordnance operations.*

b. KSC should further assess the possibility of an even earlier return of the MSS, to see if the additional benefits warrant the tradeoffs that will be required.

c. KSC should continue assessment of the possible modifications to MSS-related hardware and modus operandi which would allow reductions in SC fluid servicing timelines. Particular emphasis should be placed on those which would be directly beneficial to launch countdown and scrub-turnaround operations.

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*This recommendation has already been made to the Saturn V Countdown Working Group and is currently being evaluated.

d. KSC should continue assessment of the MSS revalidation requirements for possible deletion of the servicing system "hot flows."

e. KSC should consider the possibility of installing and removing the SHe FDU (see Appendix I) by manhandling instead of utilizing the equipment crane. The FDU was designed for manual handling. A savings of one-half hour serial time is possible for each operation.

2032-GJM-jcd

G. J. McPherson Jr.

Attachments
Figures 1-8
Appendices I-III

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8. Actual Timelines for MSS Movement - Park Site to Pad A and Return; from AS-501, in form of chart, provided by Bendix Transporter Section, E. Walsh, February 21, 1968.

9. AS-501 Support Operations-Countdown to Launch-Pad A, Operating Checkout Procedure (Bendix), SV-89018-501, Revision A dated 2 November 1967.

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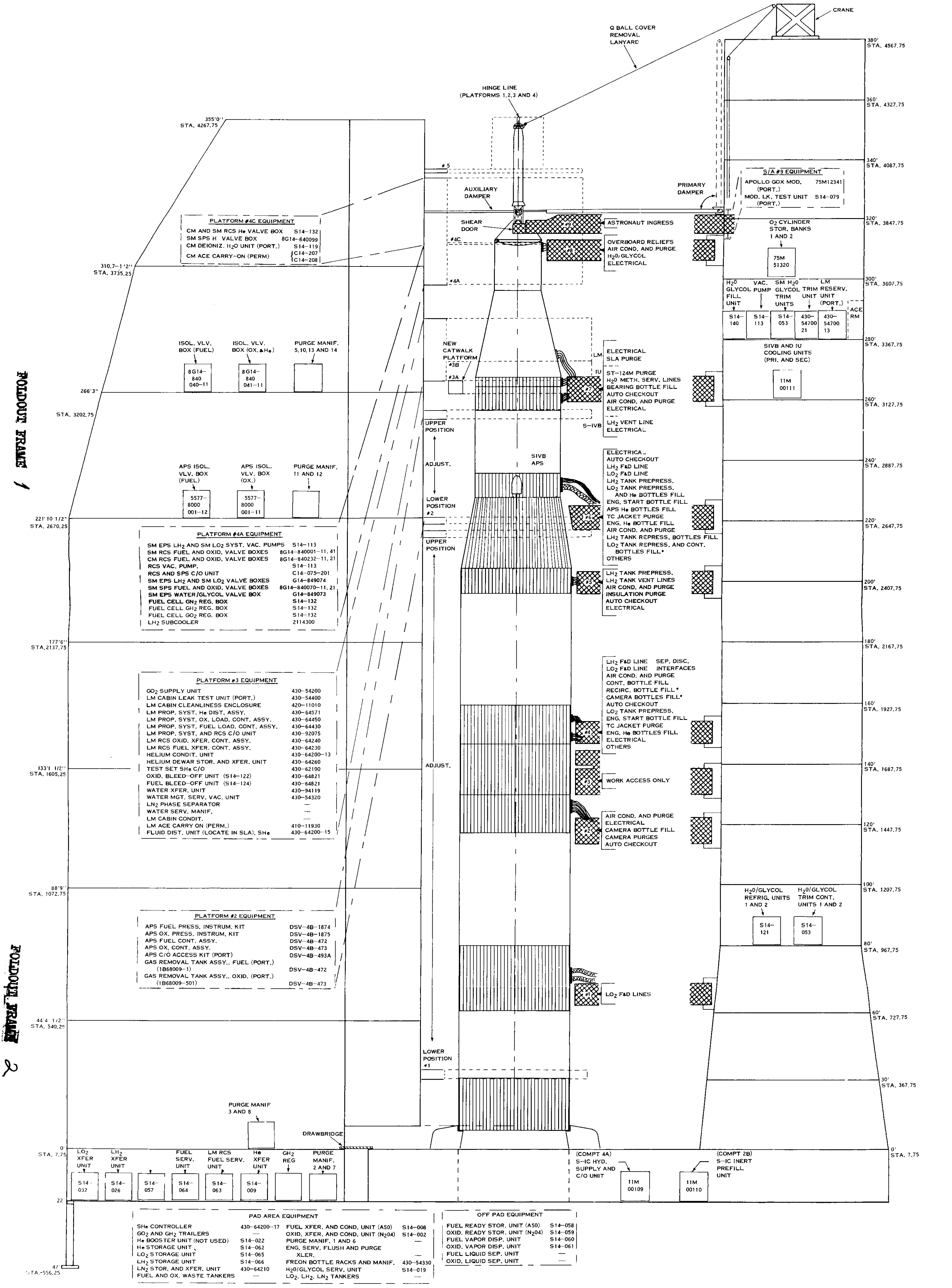
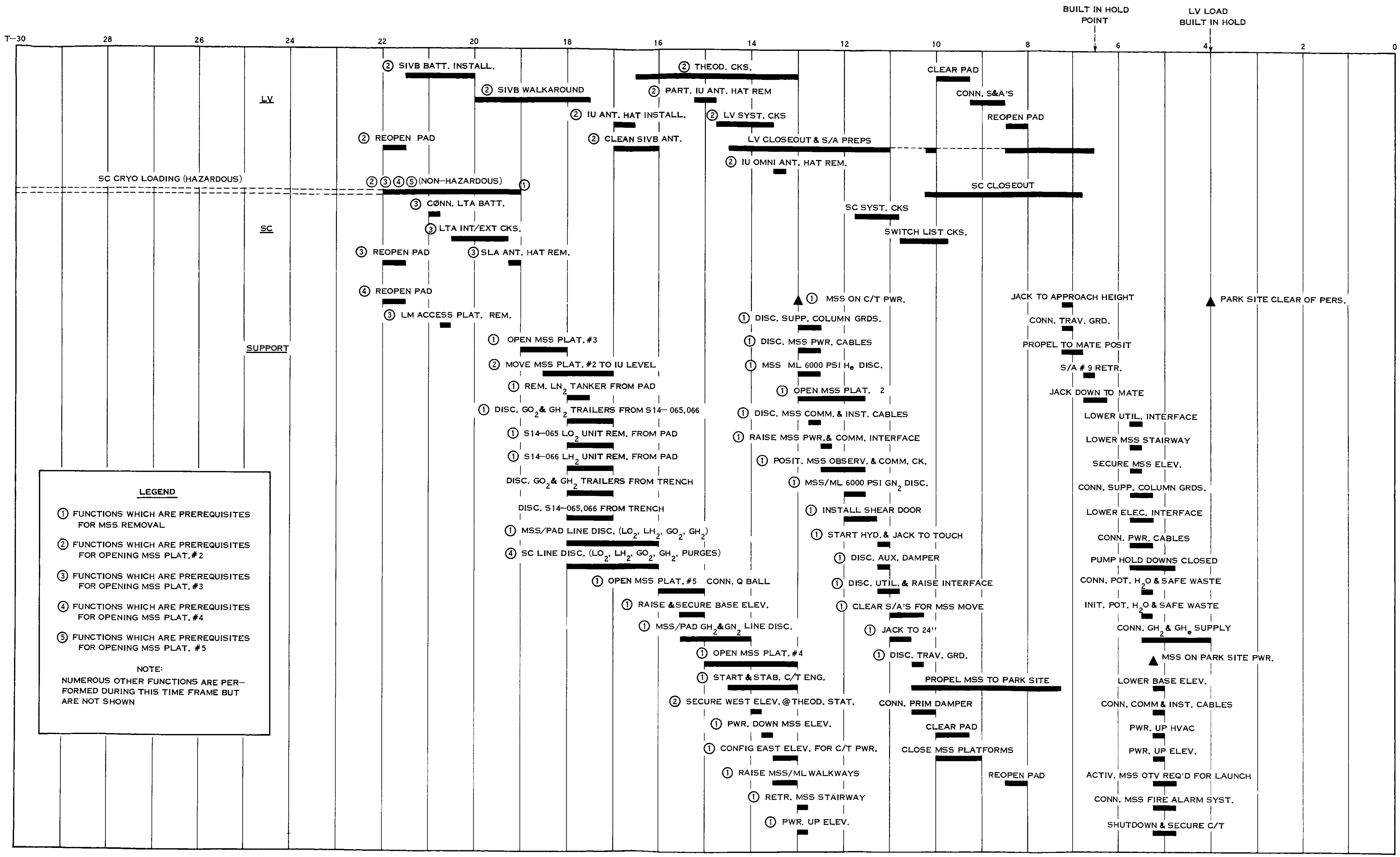
16. Letter from A. D. Mardel/Chief-Mission Support Division-MSC to G. M. Low/Manager-Apollo Spacecraft Program-MSC, Topoff of LM SHe Tank from the LUT, dated February 9, 1968.

17. Apollo Program Directive 4H, Apollo Program Schedule and Hardware Planning Guidelines and Requirements, dated November 3, 1967 <u>(Confidential).</u>



MSS/SATURN V/LUT EQUIPMENT LOCATIONS AND INTERFACES

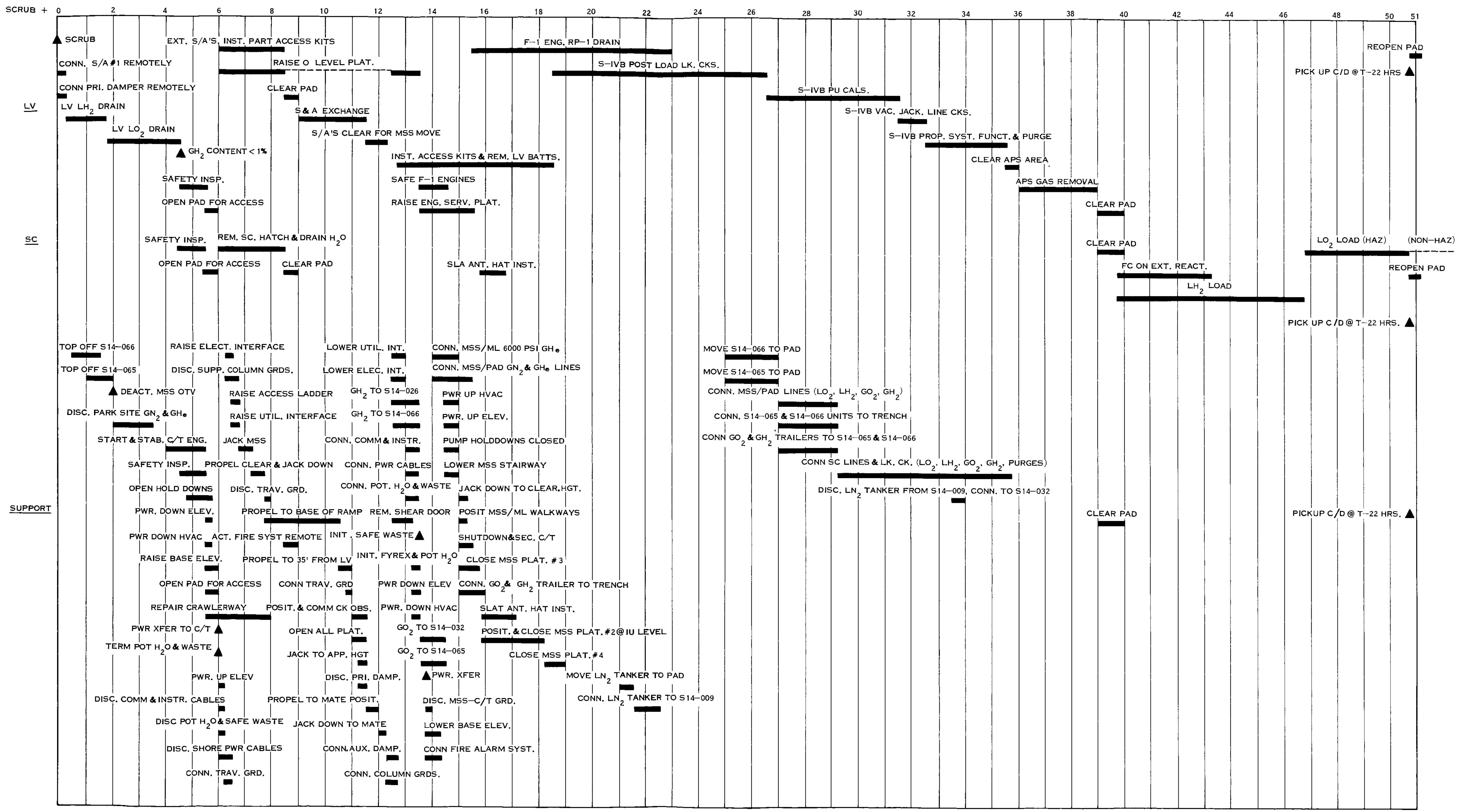
FIGURE NO. 1



AS-501 LAUNCH COUNTDOWN SUPPORT FUNCTIONS-MSS RELATED
FIGURE NO. 2

FOLDOUT FRAME 1

FOLDOUT FRAME 2



AS-501 SCRUB TURNAROUND SUPPORT FUNCTIONS-MSS RELATED
FIGURE NO. 3

FOLDOUT FRAME /

FOLDOUT FRAME 2

		READ DOWN			READ UP		
RADIAL DISTANCE (FEET)	TRAVEL DISTANCE (FEET)	ACTUAL RUNNING TIME PAD A TO PARKSITE	REMARKS	SPEED (MPH)	ACTUAL RUNNING TIME PARKSITE TO PAD A	REMARKS	SPEED (MPH)
AT PAD (JACKED UP)	AT PAD (JACKED UP)	0H 0M	SEE NOTES 1&2	0.10	2H 49M	OVER MOUNTS	0.10
35	35	0H 5M	START DOWN RAMP		2H 44M	SEE NOTE 3	
850	850	0H 45M	ON RAMP	0.25	2H 23M	ON RAMP	0.40
——	1350	IH 9M	END OF RAMP	0.50	2H 11M	START UP RAMP	0.50
——	2650	IH 39M	START STRAIGHTAWAY		IH 41M	START CURVE	
2650	2900	IH 43M			IH 37M	STRAIGHTAWAY	
3200	3650	IH 54M			IH 26M		
3600	4130	2H 0M		0.75	IH 20M		0.75
4200	4800	2H 10M			IH 10M		
4600	5290	2H 16M			IH 2M		
4800	5490	2H 19M	STRAIGHTAWAY		0H 59M	STRAIGHTAWAY	
——	6300	2H 37M	START CURVE		0H 47M	END OF CURVE	
7150	7850	3H 18M	OVER MOUNTS	0.50 SEE NOTE 4	0H 0M	AT PARKSITE (JACKED UP)	0.50 SEE NOTE 4

NOTE 1: DOES NOT INCLUDE TIME FOR SAFETY CLEARANCE
NOTE 2: DOES NOT INCLUDE TIME FOR COMM. (REQUEST/RESPOND)
NOTE 3: DOES NOT INCLUDE TIME FOR MOUNT OBSERVER COMM. CKS.
NOTE 4: SPEED IS REDUCED TO BELOW 0.1 MPH WITHIN 100—150 FEET OF PARK SITE.

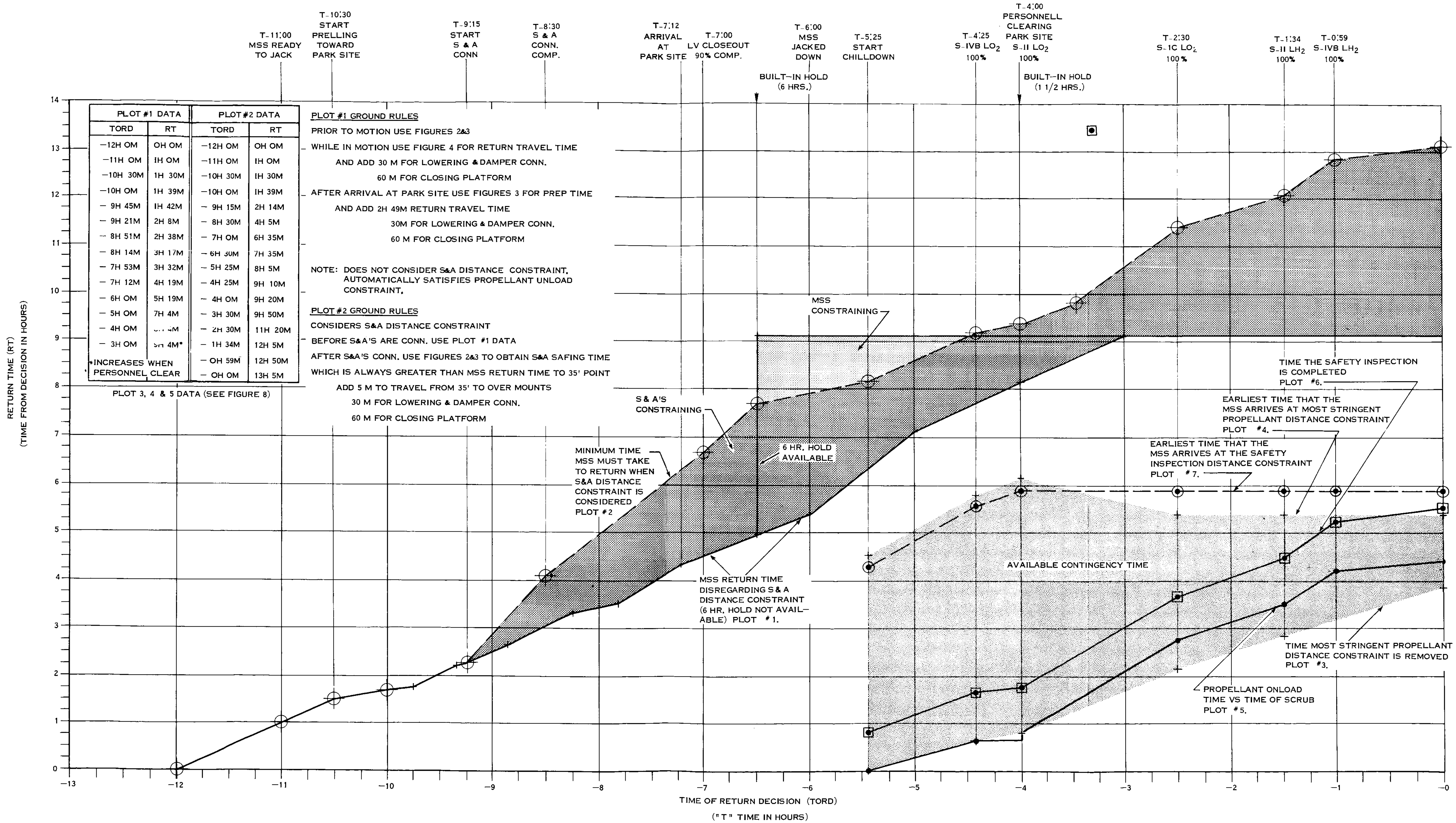
MSS TRANSFER BETWEEN PAD A AND PARK SITE
FIGURE NO. 4

	MSS REQUIRED DISTANCE FROM PAD A		COUNTDOWN		SCRUB	
LV CRYO CONFIGURATION	RADIAL	TRAVEL	NOMINAL "T" TIME OF LV LOAD	LATEST "T" TIME MSS CAN DEPART PAD A	NOMINAL SCRUB TIME OF LV UNLOAD	EARLIEST "S" TIME MSS CAN DEPART PARKSITE
START CHILLDOWN S–IVB 100% LO_2 LOAD S–II 100% LO_2 LOAD START S–IC LOAD	850 FT.	850 FT.	BETWEEN T–5H 25M AND T–4H 0M	T–6H 10M	S+4H 30M	S+2H 07M
S–IC 33% LO_2 LOAD	2650 FT.	2900 FT.	T–3H 30M	T–5H 13M	S+3H 50M	S+2H 13M
S–IC 66% LO_2 LOAD	3200 FT.	3650 FT.	T–3H 0M	T–4H 54M	S+3H 10M	S+1H 44M
S–IC 100% LO_2 LOAD	3600 FT.	4130 FT.	T–2H 30M	T–4H 30M	S+1H 45M	S+1H 25M
S–II 50% LH_2 LOAD	4200 FT.	4800 FT.	T–2H 0M	T–4H 10M	S+1H 23M	S+0H 13M
S–II 100% LH_2 LOAD	4600 FT.	5250 FT.	T–1H 34M	T–3H 49M	S+1H 0M	S–0H 3M
S–IVB 50% LH_2 LOAD	4700 FT.	5370 FT.	T–1H 15M	T–3H 33M	S+0H 38M	S–0H 22M
S–IVB 100% LH_2 LOAD	4800 FT.	5490 FT.	T–0H 59M	T–3H 18M	S+0H 0M	S–0H 59M

NOTE: THE "T" TIMES ARE BASED ON AS–501, INCLUDES THE BUILT–IN–HOLD FOR S–II LOADING.

MSS REQUIRED DISTANCES (PERSONNEL SAFETY) FROM PAD A FOR HAZARDOUS LV PROPELLANT CONFIGURATIONS

FIGURE NO. 5



PLOT #1 DATA		PLOT #2 DATA	
TORD	RT	TORD	RT
−12H OM	OH OM	−12H OM	OH OM
−11H OM	IH OM	−11H OM	IH OM
−10H 30M	1H 30M	−10H 30M	IH 30M
−10H OM	1H 39M	−10H OM	IH 39M
− 9H 45M	IH 42M	− 9H 15M	2H 14M
− 9H 21M	2H 8M	− 8H 30M	4H 5M
− 8H 51M	2H 38M	− 7H OM	6H 35M
− 8H 14M	3H 17M	− 6H 30M	7H 35M
− 7H 53M	3H 32M	− 5H 25M	8H 5M
− 7H 12M	4H 19M	− 4H 25M	9H 10M
− 6H OM	5H 19M	− 4H OM	9H 20M
− 5H OM	7H 4M	− 3H 30M	9H 50M
− 4H OM	[illegible] 4M	− 2H 30M	11H 20M
− 3H OM	[illegible] 4M*	− 1H 34M	12H 5M
*INCREASES WHEN PERSONNEL CLEAR		− OH 59M	12H 50M
		− OH OM	13H 5M

PLOT 3, 4 & 5 DATA (SEE FIGURE 8)

PLOT #1 GROUND RULES

PRIOR TO MOTION USE FIGURES 2&3

WHILE IN MOTION USE FIGURE 4 FOR RETURN TRAVEL TIME
AND ADD 30 M FOR LOWERING & DAMPER CONN.
60 M FOR CLOSING PLATFORM

AFTER ARRIVAL AT PARK SITE USE FIGURES 3 FOR PREP TIME
AND ADD 2H 49M RETURN TRAVEL TIME
30M FOR LOWERING & DAMPER CONN.
60 M FOR CLOSING PLATFORM

NOTE: DOES NOT CONSIDER S&A DISTANCE CONSTRAINT. AUTOMATICALLY SATISFIES PROPELLANT UNLOAD CONSTRAINT.

PLOT #2 GROUND RULES

CONSIDERS S&A DISTANCE CONSTRAINT

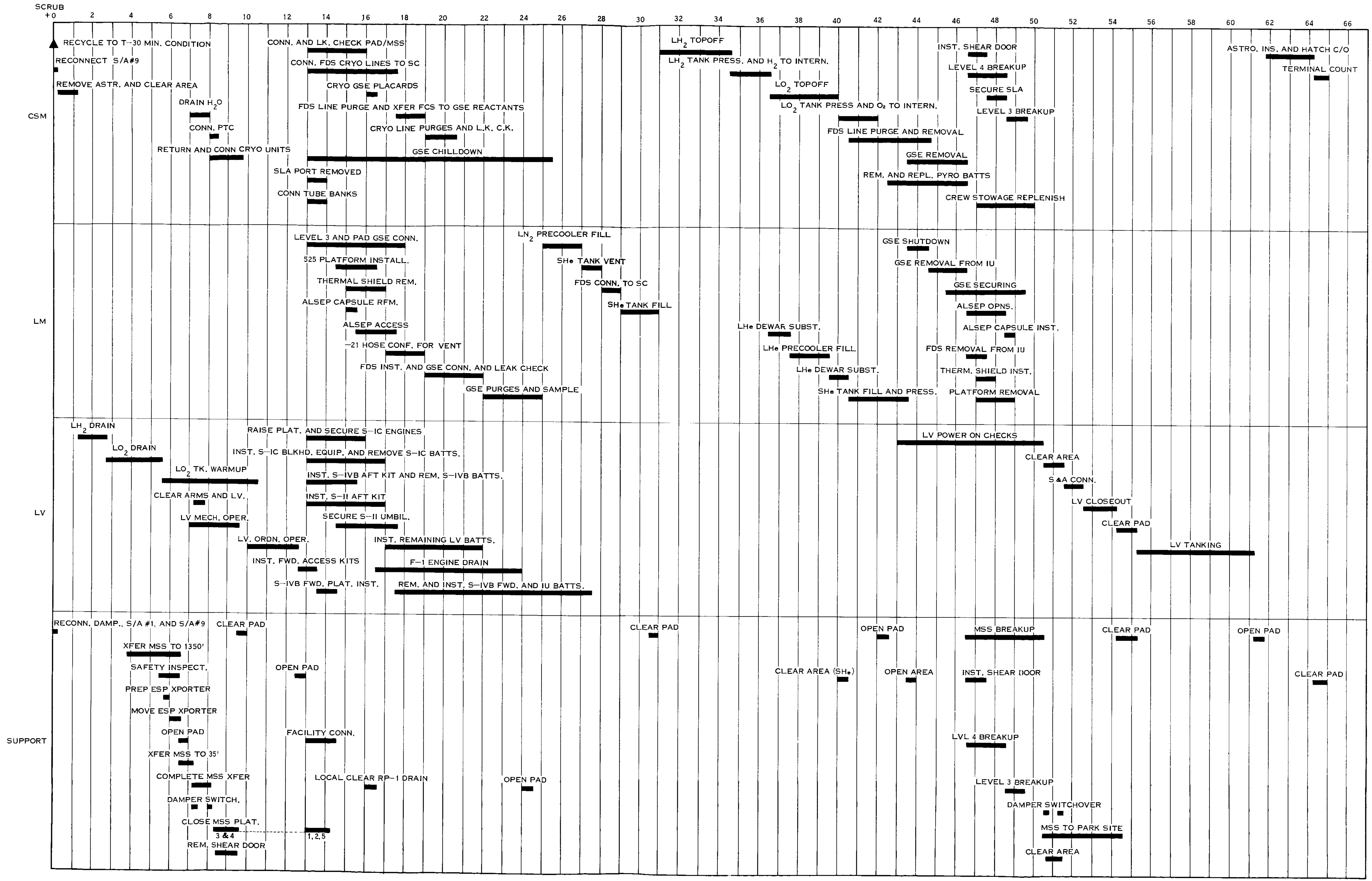
BEFORE S&A'S ARE CONN. USE PLOT #1 DATA

AFTER S&A'S CONN. USE FIGURES 2&3 TO OBTAIN S&A SAFING TIME
WHICH IS ALWAYS GREATER THAN MSS RETURN TIME TO 35' POINT
ADD 5 M TO TRAVEL FROM 35' TO OVER MOUNTS
30 M FOR LOWERING & DAMPER CONN.
60 M FOR CLOSING PLATFORM

MSS RETURN TIMES VS "T" TIME OF DECISION
FIGURE NO. 6

FOLDOUT FRAME 1

FOLDOUT FRAME 2



FOLDOUT FRAME 1

LUNAR MISSION SCRUB TURN-AROUND (MODIFIED)

FIGURE NO. 7

FOLDOUT FRAME 2

LV CONFIGURATION		MINIMUM DISTANCE CONSTRAINT (RADIAL FEET)	SCRUB AT T-5:25			SCRUB AT T-4:25			SCRUB AT T-4:00			SCRUB AT T-2:30			SCRUB AT T-1:34			SCRUB AT T-0		
			LV UNLOADED AT SCRUB PLUS (HR:MIN)	MSS READY TO TRAVEL AT SCRUB PLUS (HR:MIN)	MSS ARRIVES AT MINIMUM DIST. CONSTR. AT SCRUB PLUS (HR:MIN)	LV UNLOADED AT SCRUB PLUS (HR:MIN)	MSS READY TO TRAVEL AT SCRUB PLUS (HR:MIN)	MSS ARRIVES AT MINIMUM DIST. CONSTR. AT SCRUB PLUS (HR:MIN)	LV UNLOADED AT SCRUB PLUS (HR:MIN)	MSS READY TO TRAVEL AT SCRUB PLUS (HR:MIN)	MSS ARRIVES AT MINIMUM DIST. CONSTR. AT SCRUB PLUS (HR:MIN)	LV UNLOADED AT SCRUB PLUS (HR:MIN)	MSS READY TO TRAVEL AT SCRUB PLUS (HR:MIN)	MSS ARRIVES AT MINIMUM DIST. CONSTR. AT SCRUB PLUS (HR:MIN)	LV UNLOADED AT SCRUB PLUS (HR:MIN)	MSS READY TO TRAVEL AT SCRUB PLUS (HR:MIN)	MSS ARRIVES AT MINIMUM DIST. CONSTR. AT SCRUB PLUS (HR:MIN)	LV UNLOADED AT SCRUB PLUS (HR:MIN)	MSS READY TO TRAVEL AT SCRUB PLUS (HR:MIN)	MSS ARRIVES AT MINIMUM DIST. CONSTR. AT SCRUB PLUS (HR:MIN)
CHILLDOWN		850	0:00	2:00	4:23															
S-IVB LH_2	100%	4800																0:15	3:45	4:44
	50%	4700																0:37	3:45	4:45
	0%	4600																1:00	3:45	4:47
S-II LH_2	100%	4600													0:00	3:45	4:47	1:00	3:45	4:47
	50%	4200													0:22	3:45	4:55	1:22	3:45	4:55
	0%	3600													0:45	3:45	5:05	1:45	3:45	5:05
S-IVB LO_2	100%	850				0:00	3:15	5:38	0:00	3:45	6:08	0:00	3:45	6:08	0:45	3:45	6:08	1:45	3:45	6:08
	50%	850				0:17	3:15	5:38	0:17	3:45	6:08	0:17	3:45	6:08	1:02	3:45	6:08	2:02	3:45	6:08
	0%	850				0:35	3:15	5:38	0:35	3:45	6:08	0:35	3:45	6:08	1:20	3:45	6:08	2:20	3:45	6:08
S-II LO_2	100%	850							0:00	3:45	6:08	0:00	3:45	6:08	0:45	3:45	6:08	1:45	3:45	6:08
	50%	850							0:22	3:45	6:08	0:22	3:45	6:08	1:07	3:45	6:08	2:07	3:45	6:08
	0%	850							0:45	3:45	6:08	0:45	3:45	6:08	1:30	3:45	6:08	2:30	3:45	6:08
S-IC LO_2	100%											0:45	3:45	5:05	1:30	3:45	5:05	2:30	3:45	5:05
	66%	3200										1:25	3:45	5:11	2:10	3:45	5:11	3:10	3:45	5:11
	33%	2650										2:05	3:45	5:22	2:50	3:45	5:22	3:50	3:45	5:22
	0%	850										2:45	3:45	6:08	3:30	3:45	6:08	4:30	3:45	6:08

	MINIMUM DISTANCE CONSTRAINT (RADIAL FEET)	SAFETY INSPECTION COMPLETE AT SCRUB PLUS (HR:MIN)	MSS READY TO TRAVEL AT SCRUB PLUS (HR:MIN)	MSS ARRIVES AT SAFETY INSP. CONST. DIST. AT SCRUB PLUS (HR:MIN)	SAFETY INSPECTION COMPLETE AT SCRUB PLUS (HR:MIN)	MSS READY TO TRAVEL AT SCRUB PLUS (HR:MIN)	MSS ARRIVES AT SAFETY INSP. CONST. DIST. AT SCRUB PLUS (HR:MIN)	SAFETY INSPECTION COMPLETE AT SCRUB PLUS (HR:MIN)	MSS READY TO TRAVEL AT SCRUB PLUS (HR:MIN)	MSS ARRIVES AT SAFETY INSP. CONST. DIST. AT SCRUB PLUS (HR:MIN)	SAFETY INSPECTION COMPLETE AT SCRUB PLUS (HR:MIN)	MSS READY TO TRAVEL AT SCRUB PLUS (HR:MIN)	MSS ARRIVES AT SAFETY INSP. CONST. DIST. AT SCRUB PLUS (HR:MIN)	SAFETY INSPECTION COMPLETE AT SCRUB PLUS (HR:MIN)	MSS READY TO TRAVEL AT SCRUB PLUS (HR:MIN)	MSS ARRIVES AT SAFETY INSP. CONST. DIST. AT SCRUB PLUS (HR:MIN)	SAFETY INSPECTION COMPLETE AT SCRUB PLUS (HR:MIN)	MSS READY TO TRAVEL AT SCRUB PLUS (HR:MIN)	MSS ARRIVES AT SAFETY INSP. CONST. DIST. AT SCRUB PLUS (HR:MIN)
SAFETY INSPECTION	1350	0:00	2:00	4:11	1:35	3:15	5:26	1:45	3:45	5:56	3:45	3:45	5:56	4:30	3:45	5:56	5:30	3:45	5:56

DATA SHEET FOR PLOTS 3,4,5,6 & 7 OF FIGURE 6

FIGURE 8

FOLDOUT FRAME 1

FOLDOUT FRAME 2

APPENDIX I

DESCRIPTION OF THE MSS

A. PHYSICAL DESCRIPTION

The MSS (see Figure 1) is a 6000-ton steel frame structure some 400 feet high when standing on its four leg-like supports. When not required to support SV processing at the launch pad, the MSS is maintained at its park-site some 7150 feet away. The structure consists of nine basic open-platform levels within its framework and five vertically adjustable SV servicing platforms which protrude from its leading face. While sitting at the park-site, the MSS is restrained from horizontal and vertical movements by holddown clamp devices which attach to its four support legs. Facility interfaces at the park-site provide the necessary commodities (GN_2, GHe, water, electrical power, etc.) required to maintain and operate the MSS systems prior to its transfer to the pad.

The MSS attains its mobility via a Crawler/Transporter (C/T) vehicle which crawls beneath the structure's minus 22-foot level (lowermost platform level), between the support legs, and by means of a hydraulic jacking system, lifts the MSS and transports it to the launch pad. During its travel over the 7850-foot crawlerway, the MSS is supplied essential electrical power by the C/T vehicle. Upon arrival at its pad position, the MSS is lowered and then secured by holddown clamps similar to those at the park-site. It is then mated to the pad interfaces which will immediately make available certain commodities (GN_2, GHe, water, electrical power, etc.) and will also allow other commodities (LO_2, LH_2, GO_2, LN_2, hypergolic propellants, etc.) to be furnished from portable supply units at a later date.

Access onto the MSS can be obtained by means of a ground-level elevator (retracted during MSS transfer) which rises to the minus 22-foot, zero, and plus 12-foot levels; by means of a ground level to minus 22-foot level stairway (retracted during MSS transfer); by means of two extendable drawbridges which provide walking access between the MSS and LUT zero levels; by means of S/A #9 whenever the shear door is removed (more detail provided in Section B); and by means of S/A #8 whenever the "yellow ladder" is installed. The "yellow ladder," which passes through the top of S/A #8 is fastened to both Platform No. 4C and the inside of S/A #8.

Once on the MSS, access to its various levels can be obtained by means of two high-rise elevators which service all structural-platform levels and the five SV servicing platforms (regardless of their location). The high-rise elevators originate on the plus 12-foot level. Access can also be obtained between all structural-platform levels by means of stair and ladder devices.

The five SV servicing platforms, as shown in Figure 1, are numbered from bottom to top and are capable of providing access and servicing functions to all levels of the SV above the S-IC aft skirt. Each platform is unique. The following is a brief description of each individual platform:

Platform No. 1

Platform No. 1 is a self-propelled, single level, open platform capable of being vertically adjusted between the top of the S-IC engine fairings and one-third the way up the S-IVB aft interstage section. The platform operates on a "clamshell" principal where one-half the platform is stationary and the remaining one-half, comprised of two hinged segments, closes around the launch vehicle providing full 360-degree access.

Platform No. 2

Platform No. 2 is similar to Platform No. 1 and is capable of being vertically adjusted between the middle of the S-IVB aft interstage section and the bottom of the S-IVB forward skirt. This platform also operates on the clamshell principal but contains annulus segments which fold back to increase the platform's diameter when servicing the S-IVB aft interstage area.

Platform No. 3

Platform No. 3 is a double level, externally propelled, enclosed platform which is prior adjusted# to provide access and environmental protection to the SLA/LM combination. Level 3A services the aft portion of the SLA while level 3B services the upper two-thirds of the SLA which includes the two SLA personnel access hatches. Platform No. 3 also operates on a clamshell principal similar to Platform No. 1. A modification to Platform No. 3, effective on AS-502 and subsequent, which will allow access to the IU exterior will be discussed in Section B.

Platform No. 4

Platform No. 4 is a double level, externally propelled, enclosed platform which is prior adjusted to provide access and

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#Platforms 3, 4 and 5 are vertically adjusted by means of an external motive force prior to transferring the MSS to its pad position (adjustment is dependent upon SC configuration).

environmental protection to the Service Module (level 4A) and the Command Module (level 4C). This platform also operates on the clamshell principal similar to Platform No. 1.

Platform No. 5

Platform No. 5 is a single level, externally propelled, partially enclosed platform which is prior adjusted to provide access and environmental protection for the Launch Escape System (LES), the Q-ball assembly, and the Q-ball cover. The environmental protection consists of a split enclosure ("green house") located in the center of the platform. The enclosure is opened as the two platform halves are retracted. Unlike the other servicing platforms, Platform No. 5 retracts on straight rails without any clamshell effect.

The MSS also provides an auxiliary damper system (primary system is on the LUT) which attaches to the LES tower and eliminates undesirable SV movements from external forces during the period of time that the MSS is at the launch pad. The damper arm is located within the confines of Platform #4 just below the enclosure's roof.

Numerous pieces of support equipment, plumbing, and associated control equipment are required to provide the servicing functions for the Apollo/Saturn V space vehicle. Those located on the MSS are distributed throughout the structural levels as well as on the servicing platforms themselves. As can be seen from Figure 1, the majority of the equipment is located on the servicing platforms with smaller concentrations on the minus 22-foot, 221-foot 10 1/2-inch, and 266-foot 3-inch levels. These, along with the respective on-pad and off-pad support equipments, shall be further described in Section B.

The hoist machine room, base and NASA communication room, electrical equipment room, operations support room, and the elevator equipment room are all located on the MSS zero level.

B. FUNCTIONAL DESCRIPTION

B.1 Servicing Platforms

The five SV servicing platforms provide access to the SV for performance of various launch preparations as well as actual "servicing" functions. The following lists, along with Figure 1, identify the pertinent launch preparations and servicing functions accomplished via each platform. It should be noted that all LV battery installations, LV ordnance installations/ connections, SC battery installations, and LV internal work platform/access kit installations are accomplished without the use of the MSS servicing platforms.

Platform No. 1

a. S-IC forward film camera capsule and ordnance installation (AS-502 and AS-503 only)

b. S-IC and S-II walk-around inspections

c. S-IC and S-II mechanical closeout*

d. S-IC and S-II antenna hat installation/removal

e. S-IC and S-II stage leak checks

Platform No. 2

a. S-IVB APS modules hypergolic servicing

b. S-IVB APS modules gas removal

c. IU antenna hat installation/removal (AS-501 only)**

d. ST-124M theodolite sighting window cleaning (AS-501 only)**

e. S-IVB walk-around inspection

f. IU external inspection (AS-501 only)**

g. S-IVB mechanical closeout*

h. S-IVB stage leak checks

Platform No. 3***

a. LM cabin leak checks

b. LM GHe servicing (APS, DPS, and RCS)

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*Does not include closeout performed via the LUT S/A's.

**These functions will be performed via Platform No. 3 for AS-502 and subsequent.

***Will include all functions associated with a full-up Apollo/Saturn V space vehicle.

c. LM SHe servicing

d. LM hypergolic servicing (APS, DPS, and RCS)

e. LM H_2O servicing

f. LM and SLA ordnance installation and connection

g. LM O_2 servicing (AS and DS)

h. SLA antenna hat installation/removal

i. LM and SLA external inspections

j. LM and SLA mechanical closeouts*

k. ALSEP capsule installation/removal

l. IU antenna hat installation/removal (AS-502 and subsequent)

m. ST-124M theodolite sighting window cleaning (AS-502 and subsequent)

n. IU external inspection (AS-502 and subsequent)

Platform No. 4A***

a. SM hypergolic servicing (SPS and RCS)

b. CM hypergolic servicing (RCS)

c. SM LH_2 servicing

d. SM LO_2 servicing

e. Fuel cell activation and external reactant servicing (GO_2, GH_2, and GN_2)

f. SM water/glycol servicing

g. SM inspections

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*op.cit.

***op.cit.

h. SM mechanical closeout*

i. SM GN_2 servicing (SPS)

j. SM GHe servicing (SPS and RCS)

k. SM ordnance installation and connection

Platform No. 4C***

a. CM GHe servicing (RCS)

b. SM GHe servicing (SPS and RCS)

c. CM H_2O servicing

d. CM ordnance installation and connection

e. CM external inspection

f. CM mechanical closeout*

g. auxiliary damper arm maintenance

h. S/A #9 shear door installation

Platform No. 5

a. Q-ball assembly installation

b. Q-ball cover installation

c. Q-ball cover lanyard connection

d. LES ordnance connection

e. LES inspection

f. LES closeout

During AS-501 processing and launch countdown, all S-IVB forward and IU exterior preparations had to be accomplished

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*op.cit.

***op.cit.

from atop a ladder which was resting on servicing Platform No. 2. This was caused by Platform No. 2 being limited in its upward vertical adjustment by a physical interference in the form of equipment mounted on the underside of Platform No. 3. Because of this interference, Platform No. 2 could only be raised within 10 feet of the IU, hence, the ladder requirement.

Platform No. 2 also caused another operational problem. When at its raised location, the elevator access door mounted on the servicing platform interfered with the line-of-sight during the ST-124M theodolite checks. This test is necessarily accomplished in the same time-frame as IU antenna hat removal.

To alleviate both of these problems for AS-502 and subsequent, Platform No. 3 has been modified to include an enclosed catwalk platform which is suspended about 6 feet below Platform No. 3's main level. Access to the new platform will be available <u>only</u> from the MSS structure by means of a catwalk. The platform will circle the SV some 4 to 5 feet from the LV's periphery and provides manually operated sliding extensions at three locations to enable IU antenna installation/removal, external inspections, etc. That portion of the new platform which is underslung from the clamshell portion of Platform No. 3 will open and close accordingly.

A few interesting facts concerning the relationship of the MSS servicing platforms to the SV and LUT S/A's are discussed in the following:

<u>Platform No. 3</u>

1. Neither Platform No. 3 nor its new underslung platform offers direct access to the IU interior. Direct access is available <u>only</u> through LUT S/A #7.

2. Platform No. 3 <u>does</u> offer direct access into the SLA through either of two SLA personnel hatches.

3. To acquire access to the LM through either the IU access door or SLA personnel hatches, the internal SLA platform network <u>must</u> be installed.

<u>Platform No. 4</u>

1. Platform No. 4 <u>does</u> <u>not</u> normally offer direct access to the CM crew access hatch. The crew

access hatch is within the confines of the bellows extension tip which extends from the LUT S/A #9 "white room."

2. Direct access between Platform No. 4 (level C) and the "white room" is available whenever the "white room" shear door is removed.

3. The shear door can only be installed from Platform No. 4. Platform No. 4's clamshell does not have to be closed to install the shear door.

4. The "white room" bellows extension can be retracted and extended regardless of the configuration of Platform No. 4's clamshell (open or closed).

5. S/A #9 cannot be extended or retracted with the MSS in place, regardless of Platform No. 4's configuration, due to interference with an MSS structural member.

6. Platform No. 4 cannot be opened with the "yellow ladder" installed.

Platform No. 5

1. The Q-ball cover removal system on AS-501 consisted of a bladder device and retraction lanyard. It was connected at the time Platform No. 5 was opened. For AS-502 and subsequent, the Q-ball cover removal system will consist of a retraction lanyard which is passed through a pulley sheave mounted on the LUT hammerhead crane. As on AS-501, the lanyard will be connected to the Q-ball cover after Platform No. 5 is opened. The retract pulley sheave will also be affixed to the crane during this same timeframe. The lanyard departs from the Q-ball cover at such an angle (both vertically and horizontally) as to allow extension and retraction of the primary damper system without interference.

B.2 Damper System

The primary and auxiliary damper systems are provided by the LUT and MSS, respectively. The auxiliary damper system consists of two retractable rigid arms which extend out from the MSS structure (see Figure 1) to points on either side of the LES tower. The arms are located within the envelope of Platform No. 4C just below the enclosure's roof. Hydraulic actuated cylinders extend from the tip of each arm and grasp the LES tower legs with hook-like devices and, thus, prevent any undesirable SV movements from winds and other external forces.

The auxiliary damper system remains connected to the SV during the entire time the MSS is at the launch pad. It is disconnected just prior to transferring the MSS to its park-site during the countdowns for CDDT and launch. The damper system functions independent of Platform No. 4C and is only disconnected after all preparations have been completed for MSS jacking. The auxiliary damper arm, due to its vertical rigidity, must be disconnected prior to jacking the MSS. Conversely, it cannot be connected until the MSS is fully jacked-down.

The primary damper system is connected to the SV during all periods when the MSS is not in place at the launch pad. The primary damper arm which swings down from the LUT (see Figure 1) must be disconnected from the SV prior to moving the MSS onto its pad position. This is due to a physical interference between the damper arm and the MSS structure.

B.3 Propellant and Pressurization Systems

It can be seen from Figure 1 that the LV, with all of its large volume and time sensitive commodities, is serviced via the LUT S/A carrier interfaces and permanently installed support facilities. It can also be seen that all SC commodities and S-IVB hypergolics are serviced from the MSS platforms via support equipment on the MSS (both permanent and portable) and portable support equipment located on or near the launch pad.

The following discussions provide some insight as to which equipment is involved during each of the servicing operations, as well as which equipment supports more than a single servicing operation.

SC Hypergolics

Spacecraft hypergolic servicing can be categorized into two groups according to the volumetric requirements of the respective systems. The larger volume systems (SM/SPS, LM/APS, and LM/DPS) require mobile off-pad storage units and on-pad transfer and conditioning units to supply the propellants to the MSS isolation valve boxes. The storage units are usually filled subsequent to their arrival at their near-pad position. The smaller volume systems (CM/RCS, SM/RCS, and LM/RCS) have their storage, transfer, and conditioning functions provided by composite "servicing" units located on the MSS.

The CM/RCS and SM/RCS servicing systems (both fuel and oxidizer) and the LM/RCS servicing system (oxidizer only) are vented to atmosphere through vent stacks at the top of the MSS. The remaining hypergolic servicing systems vent through a closed system to mobile liquid separator and Toxic Vapor Disposal Units (TVDU) located away from the launch pad.

a. SM/SPS, LM/APS, & LM/DPS

The fuel, Aerozine 50 (A-50), and oxidizer (N_2O_4) servicing equipment is essentially identical (see Figure 1). The propellants are furnished from mobile ready-storage units (S14-058 and S14-059) located off the pad and fed through transfer and conditioning units (S14-008 and S14-002) on the pad and then through the pad/MSS interface to isolation valve boxes. The fuel isolation valve box located on the 266-foot 3-inch level routes the propellant to the SM/SPS through its own valve box on Platform No. 4A, and to the LM/APS and LM/DPS through a common LM propulsion system fuel loading controller on Platform No. 3. The distribution of the oxidizer propellant from the oxidizer isolation valve box is identical to that described for the fuel system. The oxidizer isolation valve box also contains GHe isolation valves for servicing the LM GHe systems.

b. CM/RCS, SM/RCS, and LM/RCS

The fuel servicing units (one with MMH for the CM/RCS and SM/RCS; one with A-50 for the LM/RCS) and an oxidizer (N_2O_4) servicing unit are located on the MSS minus 22-foot level (see Figure 1). These units are filled from facility tankers prior to movement of the MSS to the launch pad. The CM/RCS and SM/RCS fuel servicing unit (S14-064) supplies propellant through the APS fuel isolation valve box (also used for S-IVB APS servicing) to end-item controllers in the form of CM and SM/RCS fuel valve boxes on Platform No. 4A.

The LM/RCS fuel servicing unit (S14-063) supplies propellant through the main fuel isolation valve box (also used on larger volume systems) to the LM/RCS fuel transfer controller assembly located on Platform No. 3.

The distribution of oxidizer to these systems is slightly different. The oxidizer servicing unit (S14-057) supplies propellant through the main oxidizer isolation valve box (also used on larger volume systems) to end-item controllers in the form of a CM/RCS oxidizer valve box, an SM/RCS oxidizer valve box, and a LM/RCS oxidizer transfer controller assembly. The CM/RCS and SM/RCS valve boxes are located on Platform No. 4A while the LM/RCS valve box is located on Platform No. 3.

S-IVB APS Hypergolics

The S-IVB APS hypergolic servicing and gas-removal ("bladder bleed") operations are both necessarily performed from MSS Platform No. 2. This is primarily due to the location of the APS modules which are 90 degrees removed on either side from the LUT S/A interface and also due to the MSS already having hypergolic servicing capabilities as required by the CSM/RCS systems.

During APS hypergolic servicing, the fuel (MMH) and oxidizer (N_2O_4) are fed from their respective servicing units (S14-064 and S14-057) on the minus 22-foot level through isolation valve boxes on the 221-foot 10 1/2-inch level to portable end-item control assemblies on Platform No. 2. The portable control assemblies are removed upon completion of servicing and are stored at the hypergolic farm in the KSC industrial area.

The gas-removal operation is accomplished with two portable gas-removal tank assemblies, one each for fuel and oxidizer, located on Platform No. 2. Like the portable control assemblies, these units are also stored at the hypergolic farm when not in use.

Subsequent to the completion of all SC and S-IVB APS hypergolic loading, the ready-storage units and the transfer and conditioning units are removed and facility waste tankers connected at the pad/MSS interface for emergency unload capabilities. These remain connected along with the liquid separators and TVDU's until after completion of SC gaseous helium servicing, during which initial pressurization of the SC hypergolic tanks is accomplished. The SC hypergolic servicing lines, waste tankers, liquid separators, and TVDU's are all disconnected upon completion of GHe servicing.

SC Cryogenics

Spacecraft cryogenic servicing requirements are categorized into LO_2 and LH_2 for the SM, and SHe for the LM. The

SM requires LO_2 and LH_2 for the Electrical Power System (EPS) and Environmental Control System (ECS). The LM requires SHe for in-flight pressurization of the DPS propellant tanks.

a. SM EPS and ECS

The EPS (LO_2 and LH_2) and ECS (LO_2 only) requirements are satisfied via common storage vessels in the SM. LO_2 is supplied from a mobile-storage unit (S14-065) on the pad to the LO_2 transfer unit (S14-032) located on the MSS minus 22-foot level. The transfer unit in turn pumps the LO_2 to the SM via the SM LO_2 valve box on Platform No. 4A. A GO_2 trailer is connected to the mobile-storage unit to provide purge gases for drying the system lines.

The LH_2 system functions similar to the LO_2 system. LH_2 is supplied from a mobile-storage unit (S14-066) on the pad to the LH_2 transfer unit (S14-026) located on the MSS minus 22-foot level. The transfer unit pumps the LH_2 to the SM via the SM/EPS LH_2 valve box and an LH_2 subcooler, both on Platform No. 4A. A GH_2 trailer is also provided for the LH_2 mobile-storage unit.

Both mobile-storage units operate as a closed system and acquire their ullage pressure from liquid boiloff. The LH_2 subcooler utilizes a portion of the LH_2 being supplied to it from the transfer unit, in order to provide cooling for the coils carrying the LH_2 to the SC. The LO_2 subcooler is an integral part of the LO_2 transfer unit and during SC servicing uses LN_2 fed from a facility tanker as the cooling medium.

b. LM SHe (AS-503 and/or Subsequent)

Servicing the LM SHe system is considerably more involved than servicing the CSM cryogenic systems. A basic description of the equipment is necessary to understand the actual servicing operation.

Two of the main pieces of equipment are located on Platform No. 3. The first unit is the helium dewar storage and transfer unit (430-64260) which consists of portable dewar bottles, valves and associated plumbing. The dewars are filled prior to being transported to Platform No. 3 and are connected (only one at any one time) to the transfer unit. The transfer unit is in turn connected to the second unit, the helium conditioning unit (430-64200-13).

The helium conditioning unit consists of a liquid nitrogen subcooler, a helium-to-helium heat exchanger, and a liquid helium subcooler. All three are used in a progressive series to cool facility supplied GHe to a temperature just above that of liquid helium. The cooled GHe will be used to "flash" the liquid helium in the LM SHe storage vessel after it has been filled. The LN_2 for the first subcooler is supplied from a prefilled LN_2 storage and transfer unit (430-64210) located on the launch pad. The liquid helium for the final subcooler is supplied from the dewar storage and transfer unit. The cold helium gas for the helium-to-helium heat exchanger is taken directly from the liquid helium subcooler in the form of boiloff gases.

The only other unit required besides a SHe controller assembly (430-64200-17) for remote control, is the fluid distribution unit (430-64200-15) which is located on and secured to work platforms on the S-IVB forward dome. The unit weight approximately 80 pounds and is currently installed utilizing a portable equipment crane. This unit is the interface between the helium conditioning unit and the LM SHe servicing disconnect.

The servicing sequence begins with the LM SHe storage vessel being filled with liquid helium for precooling purposes. This is supplied from the dewar through the conditioning unit (though not conditioned in any way), to the fluid distribution unit, and then into the LM. A second dewar bottle is then used to fill the liquid helium subcooler. After the LM SHe storage vessel has chilled sufficiently, a third dewar bottle is used to fill it to overflow; liquid flow is then terminated.

The tri-stage cooled GHe is then provided by the helium conditioning unit to the fluid distribution unit and in turn to the LM SHe storage vessel. The slightly warmer gas "flashes" the liquid helium, causing it to become supercritical. The system is then "buttoned up" at an initial pressure of approximately 100 psia.

FC External Reactants

The SM fuel cells are activated from externally supplied GO_2 and GH_2. They are also subsequently maintained in operation on the external reactants during periods when it is impossible (prior to cryo tank loading and during vent/topoff operations) or undesirable (when adequate mission loads would be depleted) to operate them from internal supplies.

The GO_2 is supplied from a facility trailer on the pad through the LO_2 transfer unit (S14-032) on the MSS minus 22-foot level to a fuel cell GO_2 regulation box located on Platform No. 4A and in turn to the SM disconnect. The GH_2 is furnished identically through its own respective trailer, transfer unit (S14-026), and regulation box.

Gaseous Helium

Gaseous helium is required by the CSM for SPS and RCS propellant systems pressurization. It will also be required on both stages of the LM for APS, DPS, and RCS propellant systems pressurization.

a. SM/SPS, CM/RCS, and SM/RCS

GHe from the 6000 psi facility supply is furnished to a helium storage unit (S14-062) on the launch pad and also to a helium transfer unit (S14-009) located on the MSS minus 22-foot level. The storage unit is available as a backup supply but normally is not used to supply the GHe servicing requirements. The helium furnished to the transfer unit is fed to a common CM-SM/RCS helium valve box and also to an SM/SPS helium valve box, both located on Platform 4C. The GHe is then fed to the respective CM and SM servicing interfaces.

b. LM/APS, LM/DPS, and LM/RCS

Servicing of the LM GHe systems is very similar to servicing the CSM systems. GHe is fed from the same helium transfer unit to an isolation valve box on the MSS 266-foot 3-inch level and in turn to the LM propulsion system helium distribution assembly (430-64571) located on Platform No. 3. This single distribution assembly services all three LM GHe systems.

Gaseous Oxygen

Gaseous oxygen is required for CM cabin pressurization and leak checks. Both of these requirements are satisfied by equipment and interfaces furnished via the LUT and S/A #9. Gaseous oxygen is also required by the LM for cabin leak checks and GO_2 storage sphere servicing (AS and DS).

The GO_2 required by the LM for cabin leak checks is supplied from the same source on the LUT as is the CM requirements, that is, two banks of GO_2 storage cylinders on the 300-foot level (see Figure 1). The GO_2 is furnished to the LM cabin leak test unit (430-54400) on Platform No. 3 via S/A #7.

The GO_2 required for servicing the LM/AS and LM/DS GO_2 storage spheres is supplied directly from a prior filled GO_2 supply unit (430-54200) located on Platform No. 3. The AS and DS GO_2 storage spheres are planned to be serviced during the launch countdown.

Gaseous Nitrogen

Gaseous nitrogen is required by the SM for both the fuel cell GN_2 spheres and the SPS engine ball valve control storage spheres. Both systems are furnished GN_2 from the facility fed MSS supply. The GN_2 for the fuel cell spheres is fed through a fuel cell GN_2 regulation box on Platform No. 4A and then to the SM interface. The fuel cell spheres are pressurized during fuel cell activation.

The GN_2 for the SPS storage spheres is fed through the SM/SPS helium valve box located on Platform No. 4C and then to the SM interface. The SPS storage spheres are serviced during SPS functional checkout prior to hypergolic loading.

B.4 Other

Various other services are provided by the MSS, such as, electrical power; fire protection; lighting; safety showers and eye-wash conveniences; OTV; and lightning protection. None of these is seen as a constraint upon the operation at LC-39 and will not be described herein.

APPENDIX II

MSS PLATFORM LAUNCH COUNTDOWN OPERATIONS

Platform No. 1

On AS-501, Platform No. 1 was opened at approximately T-36 hours on a non-interference basis; for AS-502 and AS-503, it will be required later in the countdown for access to the S-IC forward film camera system. Breakup will occur at T-14 1/2 hours* for AS-502 and AS-503. For SV's subsequent to AS-503, platform breakup will probably return to the earlier time-frame.

Platform No. 3

On AS-501, Platform No. 3 was opened at T-19 hours. This was based on the latest time that the SLA antenna hat could be removed without impacting the breakup of Platforms 2, 4, and 5. For AS-502 and/or subsequent, Platform No. 3 will be required later in the launch countdown for LM SHe and ALSEP activities as well as for launch vehicle activities.

The SHe activities will involve disconnection and removal of GSE hardware from the platform. The ALSEP activities will involve final closeout of the SLA port through which the ALSEP capsule is passed.

The LV activities will include the S-IVB forward and IU functions which were performed from Platform No. 2 during the AS-501 launch countdown. This has been made possible by the Platform No. 3 modification previously described in Section B.1.

On AS-502, the breakup of Platform No. 3 will occur at T-14 1/2 hours in parallel with Platform No. 1 breakup.

Platform No. 2

On AS-501, Platform No. 2 was moved to its uppermost position at T-18 1/2 hours to facilitate work on the S-IVB forward and IU exteriors. Prior to this time, it had been required in its lowermost position for S-IVB APS closeout activities and

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*To compare the AS-501 launch countdown times with AS-502 times, subtract 1 1/2 hours from the AS-502 times. This is due to the deletion of the 1 1/2 hour hold (S-II LO_2 loading) in the AS-502 launch countdown.

the S-IVB walk-around inspection. It remained at its raised position until after IU antenna hat removal and was broken up at T-13 hours. This caused the operational problems discussed in Section B.1 which resulted in the modification to Platform No. 3. For AS-502 and subsequent, Platform No. 2 will not be required at its raised position; breakup is planned for T-19 1/2 hours.

Platform No. 5

Platform 5, which affords environmental protection for the LES and Q-ball systems, is broken up as late as practical without impacting other MSS breakup functions. On AS-501, the platform was broken up at T-16 hours, at which time the Q-ball cover lanyard and pneumatic line were connected.

For AS-502 and AS-503, the platform is planned to be broken up at T-19 hours. This earlier breakup was necessitated by the requirement to move Platform No. 3 breakup to a later time in the launch countdown. The Q-ball cover removal system, which has been modified for AS-502 and subsequent, will still be connected at the time Platform No. 5 is opened.

Platform No. 4

Platform No. 4 breakup is dependent upon completion of SM cryogenic servicing and associated GSE removal. On AS-501, Platform No. 4 was broken up at T-15 hours. For AS-502, the breakup of Platform No. 4 will be scheduled at T-17 1/2 hours. Like Platform No. 5, this has been necessitated by the requirement to breakup Platform No. 3 later in the countdown.

APPENDIX III

MSS RETURN TIMES AND CONSTRAINTS

Plot #1

Plot #1 reflects the minimum MSS return time for scrubs occurring at various "T" times in the launch countdown. This plot is purely a function of MSS preparations and travel time and does not consider any distance constraints (S&A or propellant). The plot indicates its initial point just after T-12 hours when the last of the MSS platforms are broken up. The return time increases almost linearly as MSS breakup and subsequent transfer operations take place. The MSS is fully secured at the park-site at T-4 hours and the operating personnel depart for their assigned launch location. An additional hour of return time is realized as the personnel evacuate the park-site. The return time for the fully secured MSS reaches its peak value at T-3 hours and remains constant for all scrubs subsequent to that time.

Plot #1 can also follow an alternate path, dependent upon how much of the planned built-in hold remains unused at the time the countdown arrives at T-6 1/2 hours. If the entire hold (or at least 4 hours 10 minutes) is available at T-6 1/2 hours, then plot #1 will increase vertically to its peak value prior to resumption of the countdown (see Figure 6). If a hold of less than 4 hours 10 minutes remains then plot #1 will increase vertically for an amount of time equal to the hold before resuming a path similar in slope to the basic plot.

The length of hold can then be said to determine at what "T" time the return time will reach its peak value but will not alter its magnitude.

Plot #2

Plot #2 reflects the minimum time that must be expended in returning the MSS to the launch pad to prevent violation of the S&A distance constraint. The S&A distance constraint requires that the MSS (if personnel are aboard) be a minimum of 35 feet from the SV during S&A operations.

In comparing plots 1 and 2, it can be seen that the S&A's constrain return of the MSS from the time that they are connected and continue to be a constraint for all scrubs subsequent to that time. The heavily shaded area between plots 1 and 2 is indicative of the magnitude of the S&A constraint for the various "T" times of scrub.

The lightly shaded area above plot #2 is indicative of the magnitude of the MSS constraint were the entire 6 hours of hold still available at T-6 1/2 hours. This shows that for scrubs between T-6 1/2 hours and T-4 1/2 hours, the S&A distance constraint would be removed prior to the MSS arriving at the 35-foot point.

Plots #3 and 4

Although it was previously mentioned that the propellant distance constraints were not considered for plot #1, the propellant distance constraints do in fact fall below plot #1 and are less constraining than the MSS itself. This could not be shown by a simple plot because of the numerous variables involved, e.g., scrub time, distance constraint constantly changing as the propellants are unloaded, unload sequence and timelines different from loading sequence and timelines, etc.

Plots #3 and 4 provide a visual indication that the propellant distance constraints will always be less constraining than the MSS inherent capabilities. They have both been extracted from the data shown in Figure 8. The data in Figure 8, in turn, has been collected from Reference 2 and Figures 3, 4 and 5. Figure 8 includes the following data:

a. various LV propellant configurations and their associated distance constraint

b. nominal unload times for each scrub time identified

c. when the MSS can be ready to commence its horizontal travel for each scrub time identified

d. when the MSS would arrive at each distance constraint for each scrub time identified

e. safety inspection constraint times for each scrub time identified

f. when the MSS would arrive at the safety inspection constraint distance for each scrub time identified

The points for plots #3 and 4 were then selected by comparing the times for items b and d above, to each other, for each scrub time identified. The times being closest to each other were selected as the most constraining points.

Plot #3, then, indicates the time that the most stringent propellant distance constraint is removed as a result of the unload operation. Plot #4 indicates the earliest possible time that the MSS could arrive at that same constraint distance. In comparing the two, the shaded area between them is indicative of how long propellant unload could be delayed without impacting return of the MSS. The worst situation is encountered for a scrub occurring at T-0 where a difference of only 1 hour 32 minutes exists. This means that a delay in propellant unloading of greater than 1 hour 32 minutes would necessitate a delay in the return of the MSS.

Plot #5

Plot #5 has also been extracted from Figure 8 and indicates the total LV propellant unload time for each scrub time identified.

Plots #6 and 7

Another distance constraint which must be considered when returning the MSS to the launch pad is associated with the safety inspection. This prohibits personnel inside the perimeter fence (approximately 1200 feet from the SV) until the pad has been declared safe. Plots #6 and 7 reflect the relationship between completion of the safety inspection and the MSS arrival at the constraint distance (assumed to be 1350 feet for this study).

It can be seen that the worst case for an AS-501 type countdown exists for scrubs at T-0 where a delay of greater than 26 minutes would require a delay in the return of the MSS. This situation will become even more constraining for scrubs with a flight crew aboard. Egress of the flight crew will add one hour to the safety inspection completion times, causing Plot #6 to move vertically upward a like amount.

For manned missions then, the return of the MSS must be delayed outside of the safety inspection constraint distance for any scrubs occurring after T-75 minutes in the launch countdown. Hence, for a manned or lunar Apollo/Saturn V SV, it may be concluded that for a scrub at T-0:

a. The MSS is capable of being returned to the launch pad in 9 hours and 4 minutes without violating any propellant unload distance constraints.

b. S&A distance constraints would require delaying the MSS return by 4 hours.

c. Safety inspection distance constraints would require delaying the MSS return by only 34 minutes.

d. If the S&A distance constraints can be circumvented, the MSS can be returned some 3 hours 26 minutes earlier than presently planned.